Annual Report (May 1, 2006 – September 30, 2007)

Sheepshead, *Archosargus probatocephalus,* Population Dynamics in Chesapeake Bay, Virginia

by

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Table of Contents

EXECUTIVE SUMMARY

In this report we present the results of evaluating sheepshead *Archosargus probatocephalus* population dynamics in Chesapeake Bay, Virginia, from our first year study. Due to the extension of the project for the first year, this report also covers the work between May of 2007 and September of 2007. By the end of September of 2007, we collected 178 and 93 fish in 2006 and in 2007, respectively. The fish were collected from recreational anglers, commercial fishermen, and fishery independent juvenile trawl surveys. The fish collected in 2006 were used to examine age composition, growth rates, and reproduction status of sheepshead population in Chesapeake Bay, Virginia. Currently, we are working on the fish collected in 2007. The first year study indicated that there could be a local population of sheepshead in Chesapeake Bay due to following three findings: 1) sheepshead spawned in May and June of 2006, 2) there were young-of-the-year (YOY) fish in Chesapeake Bay, and 3) sheepshead were larger-at-age and grew more quickly in Chesapeake Bay than in the South Atlantic and Gulf of Mexico. This report consists of five sections: Summary, Methods, Results, Discussion, and References.

Because we have mainly relied on recreational anglers to collect fish, this project requires very good communication and collaboration between anglers and us. To enhance the communication and collaboration, we have contacted recreational anglers in Chesapeake Bay in a variety of ways, such as through the Virginia Coastal Conservation Association (VA CCA), different angler's clubs, different marinas, two local radio shows, an internet website, and personal communication with anglers. Apparently, our efforts have been very effective. With strong support from the anglers and VMRC employees, we have obtained a total of 271 fish over the past two years. During our third year, we will continue to work closely with both recreational anglers and commercial fishermen in Chesapeake Bay to collect sufficient data and to provide more accurate results on sheepshead population dynamics in Chesapeake Bay, Virginia.

COLLABORATIONS

The organizations that have collaborated on this project are:

1. Virginia Coastal Conservation Association (VA CCA)
2. Little Creek Marina
3. Taylors Landing Marina
4. Wallace's Bait and Tackle Marina
5. Bubba's Marina
6. Long Bay Pointe Marina
7. The Marina at Marina Shores.
8. Tidewater Anglers Association
9. Norfolk Anglers Club
10. Tidewater Kayak Anglers Association
11. Peninsula Saltwater Sport Fishing Association
12. Eastern Shore Angler's Association
13. Portsmouth Angler's Association
14. Radio Station AM 850

15. Radio Station AM 1490
16. “Catchin’ With Captain Reese” Radio Show
17. Don Lancaster’s Radio Show
18. OmerDiving and Mark Labocetta

ACKNOWLEDGEMENTS

We thank Jeff Deem, Tom Powers, and Larry Snider for their support in initiating and helping this project. Specific thanks goes to Mr. Connie Barbour, Mr. Mark Laboccetta, and Captain Steve Wray at Long Bay Pointe Marina and Dee Carstens at The Marina at Marina Shores for their extra effort on helping to collect fish samples. We would like to thank all anglers who donated their sheepshead or sheepshead carcass to this study. We thank Joanie Beatley, Tara Bushnoe, Richard Hancock, and Myra Thompson at Virginia Marine Resources Commission for their efforts in collecting fish samples from commercial fisheries. We thank Jacques von Montefrans at Virginia Institute of Marine Sciences for helping us on the independent sampling. We thank Billy Culver, William Thompson, and Stacy Beharry for their hard work in the field and laboratory.

Sheepshead, *Archosargus probatocephalus,* Population Dynamics in Chesapeake Bay, Virginia Progress Report (February 1, 2006 – May 31)

SUMMARY

From May 1, 2006 to September 30, 2007, we had collected 271 sheepshead *Archosargus probatocephalus*. One hundred and seventy-eight fish were collected in 2006, including 10 YOY fish, and 93 fish were collected in 2007, including 50 YOY fish. Age composition, growth rates, and reproduction status of sheepshead were examined using the fish collected in 2006. Currently, we are working on the fish collected in 2007, and will report the result in the next annual report.

Among the fish collected in 2006, 107 were female, 61 were male, and ten are YOY. The average age was 11 years and the standard deviation was 6.5. Twenty-five age classes (0, 3 to 20, 22 to 24, 29, and 32 to 33) were represented, comprising fish from the 1973-1974, 1977, 1982-1984, 1986-2003, and 2006 year-classes. Fish from the 1997, 1998, and 2001 year-classes dominated the sample because of size selection in the fishery.

Sheepshead grew more quickly with larger body sizes at age in Chesapeake Bay than in the South Atlantic and Gulf of Mexico. Both macroscopic and microscopic analysis indicated that sheepshead spawned in Chesapeake Bay between May and June and were multiple spawners. With the presence of YOY, there could be a local population of sheepshead in Chesapeake Bay, Virginia.

METHODS

I. Field work

1) Sample collection in 2006

i) Recreational sampling

From May to November of 2006, we worked closely with the VA CCA, local marinas, angler's clubs, and anglers in person to collect recreational caught sheepshead. Mr. Larry Snider from the VA CCA has voluntarily acted as the project coordinator between the VA CCA and ODU, enhancing communication between the recreational anglers and us. We had a meeting with Mr. Tom Powers from the VA CCA, and discussed many details on how to promote the project, how to communicate with anglers, and how to collect data, etc. We have located coolers with ice at Long Bay Pointe Marina every day and at Little Creek Marina, Taylor's Landing Marina, Bubba's Marina, and Marina at Marina Shores on weekends along Shore Drive from Norfolk to Virginia Beach. Later, the cooler at Bubba's Marina was moved to Wallace's Bait and Tackle for seven days a week because virtually no fish had been collected from Bubba's Marina. Recreational anglers are encouraged to donate their sheepshead or sheepshead carcass at each of these locations. The owners and managers at Long Bay Pointe Marina and Wallace's Bait and Tackle voluntarily checked the coolers everyday.

To promote collection of fish, we gave a presentation about this project to the Tidewater Anglers Association, Norfolk Anglers Club, and the Tidewater Kayak Anglers Association, and gave an introduction about the project in the

newsletters of the Peninsula Saltwater Sport Fishing Association and the Eastern Shore Angler's Association. We appeared on two radio shows, one at radio station AM 1490 with Mr. Don Lancaster and the other with Catchin' with Captain Reese on AM 850. We have also contacted many individual anglers personally who are known to specifically target sheepshead and they have been eager to participate in the project. We distributed project brochures to these marinas and to angler's clubs and developed a sheepshead research website where fishermen could check the ages, sex, and maturity of the fish they have donated (http://www.odu.edu/sci/cqfe/species%20studied/sheepshead/sheepshead%20project/sheepshead%20project.htm). At the website, fishermen also can monitor the progress of the project so that they will know where and how to help the project in the future.

ii) Commercial sampling
Between May and November, we collected sheepshead from commercial fisheries with the help of the Virginia Marine Resources Commission (VMRC). VMRC employees sampled the commercial sectors daily and collected all the sheepshead they intercepted for us.

2) Sample collection in 2007

i) Recreational sampling
In 2007, we continued to work with recreational anglers closely. We left the coolers in the same five marinas as we did in 2006 and distributed the brochures of the sheepshead project to each marina to promote the project. Due to successful collaboration between us and the recreational anglers in 2006, The Marina at Marina Shores started to voluntarily help us to check the cooler everyday in 2007 while Long Bay Pointe and Wallaces marinas continued to do so as they did in 2006. Due to no fish collected in Wallace's Marina during the early summer of 2007 and the placement of a VMRC freezer at the site, we withdrew the cooler from it in mid summer. To increase the sample size, we hired a charter boat for one day to collect sheepshead in June of 2007.

ii) Commercial sampling
Between May and September, we collected sheepshead from commercial fisheries with the help of the Virginia Marine Resources Commission (VMRC). VMRC employees sampled the commercial sectors daily and collected all the sheepshead they intercepted for us.

iii) Independent sampling
Because most of sheepshead we collected from the recreational and commercial fisheries were larger than 21 in. and older than 4 years old in 2006, we started our independent sampling with the collaboration of Virginia Institute of Marine Sciences (VIMS) in 2007. The independent sampling allowed us to collect younger sheepshead from VIMS's spotted seatrout (*Cynoscion nebulosus*) trawling collection during the summer and fall on Chesapeake Bay seagrass beds.

2. Lab work

Once fish were collected, they were brought back to the Center for Quantitative Fisheries Ecology (CQFE) at Old Dominion University (ODU). Fish were immediately processed in the lab. Fish were measured to 1 mm (0.04 inch) and weighed to 0.001 pound. Their otoliths and gonads were removed. The gonads were weighed fresh to 0.1 g. and preserved in 10% buffered formalin for

further histological analysis. We also removed sheepshead scales, opercula, pelvic spines, and stomachs which can be used in other studies on sheepshead in Chesapeake Bay, Virginia.

The otoliths were secured to microscope slides, and sectioned on a Buehler Isomet saw equipped with two Norton diamond wafering blades separated by a 0.4 mm stainless steel spacer, positioned so that the wafering blades straddles the focus of the otolith, thus producing an otolith cross section. The otolith sections were placed on labeled glass slides and covered with a thin layer of Flo-texx mounting medium (Figure 1).

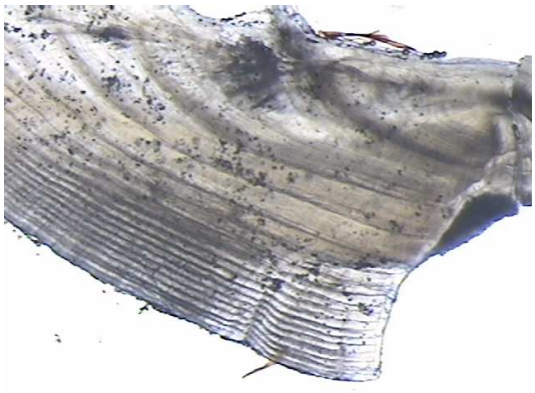

Figure 1. Otolith cross-section of a 17 years old sheepshead caught in Chesapeake Bay in 2006.

Before being preserved in formalin, gonads were macroscopically evaluated for maturity from Stage 1 to 5. Female Stage 1 to 5 are defined as follows:

1) Ovaries are small and tubular with many blood vessels;
2) Ovaries are large with colored liquid in them;
3) Small eggs are present and granular looking;
4) Eggs are ripe and flow freely, indicating that the fish are spawning;
5) Ovaries are large but deflated with some remaining eggs, indicating that the fish had spawned.

Department of Pathobiological Sciences at Louisiana State University (LSU) helped us to make histology slides for histology analysis (microscopic analysis). Before the ovaries were sent to LSU, they were prepared as follows:

i) Select a portion of the ovaries (usually the middle portion) and slice a cube about 1 x 1 x 1 cm.

ii) Rinse the sample with tap water 3 times, for 30 minutes each.

iii) Transfer the sample from the final tap water rinse to 70% Ethanol in a 50-ml glass jar and seal it with the cap.

3. Age determination

Sections of otoliths were read under a microscope using polarized light and an image analysis system. Procedures to establish quality assurance and reliability of age readings were incorporated into our laboratory protocols. We measured precision between age readings done by two readers so that we had consistency. Otoliths were read with no prior knowledge of fish length. All samples were read twice by another reader to test consistency between readers (Campana et al. 1995). We used a symmetry test to measure precision and to observe tendencies to over- or underestimate age (S-Plus 1999).

Marginal incremental analysis (MIA) was used as a validation method to examine the periodicity of annulus formation on the sheepshead otolith. Marginal increment is

referred to as the average state of completion of outermost increment:

$$c = \frac{w_i}{w_{i-1}} * 100,$$

where w_i is the distance from the last dark band or last annulus to the otolith edge and w_{i-1} is the distance between the last annulus to the previous annulus. c ranges from 0 to 100% (Campana 2001).

Without the knowledge of the otoliths collection dates, we measured the marginal increment of sheepshead otoliths using the Image-Pro Plus 5.0 system connected to an Olympus BX41 microscope. When plotted against season, the average marginal increment should display a yearly sinusoidal cycle, indicating a periodicity of annulus formation on the otolith (Campana 2001).

4. Growth

A von-Bertalanffy growth model was fitted to total length at age for both male and female sheepshead. Kimura's likelihood ratio test (Kimura 1980) was used to examine the difference between male and female growth rates. When there was no significant difference between the male and female growth rates, a von-Bertalanffy model for pooled sexes was developed. This model then was compared to von-Bertalanffy models of sheepshead growth reported in previous studies.

6. Maturity and spawning season

We classified oocyte developmental stage as follows (Abookire 2006):

1) Early yolked oocytes (EY),
2) Advanced yolked oocytes (AY),
3) Migratory nucleus oocytes (MN),
4) Hydrated oocytes (HY),
5) Postovulatory follicles (POF).

A mature spawning female will have either MN or HY oocytes or AY oocytes combined with POF. A mature postspawning female will have only POF. When all the oocytes developmental stages can be seen in a histological slide from individual fish during spawning season, the species will be identified as a multiple spawner (Render and Wilson 1992; Abookire 2006).

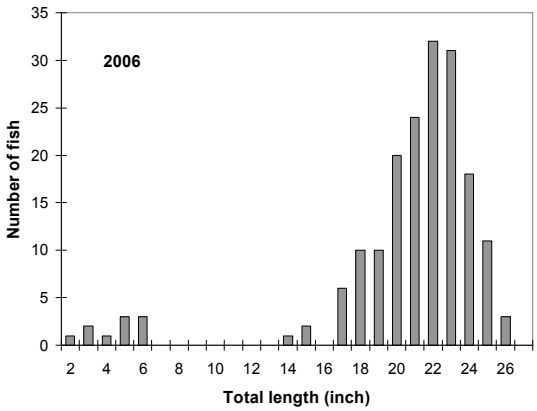

Figure 2. Length distribution of sheepshead caught in Chesapeake Bay from early May to early November in 2006.

RESULTS

1. Sample collection

We collected 178 sheepshead between early May and early November of 2006, of which, one hundred and twenty-four fish were obtained from recreational anglers and 54 fish were obtained from the commercial fisheries. Among those fish, 107 were female, 61 were male, and 10 were young-of-the-year, making a sex ratio of female to male 1:0.57. The fish total lengths ranged from a minimum of 2.7 in. (69 mm) to a maximum of 26.7 in.

(679 mm). The fish in the length interval of 22 in. dominated the sample (Figure 2). The fish weights ranged from a minimum of 0.01 lbs. to a maximum of 19.9 lbs.

We collected 93 sheepshead between May and September of 2007, of which, forty-two fish were obtained from recreational anglers, 1 fish from commercial fisheries, and 50 fish from the independent sampling. Among those fish, 19 were female, 17 were male, 50 were young-of-the-year, and 7 were unknown sex. The female to male sex ratio was 1:0.9 . The fish total lengths ranged from a minimum of 0.99 in. (25 mm) to a maximum of 26.25 in. (661 mm). The number of small fish (< 5 in.) in the sample increased significantly in 2007 than in 2006 (Figure 3). The fish weights ranged from a minimum of 0.001 lbs. to a maximum of 13 lbs.

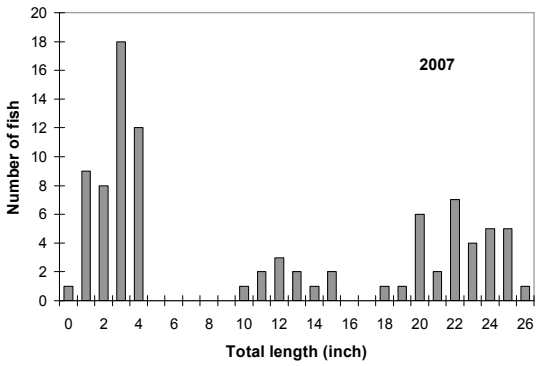

Figure 3. Length distribution of sheepshead caught in Chesapeake Bay from early May to September in 2007.

2. Age determination

One hundred and seventy-seven sheepshead collected in 2006 were aged using otolith sections (We were unable to age one fish due to its damaged otoliths). The ages of the 177 sheepshead ranged from a minimum of 0 years old (young-of-the-year) to a maximum of 33 years old with the average of 11 years with a standard deviation of 6.5 years. Twenty-five age classes (0, 3 to 20, 22 to 24, 29, and 32 to 33) were represented, comprising fish from the 1973-1974, 1977, 1982-1984, 1986-2003, and 2006 year-classes. Fish from the 1997, 1998, and 2001 year-classes dominated the sample (Figure 4).

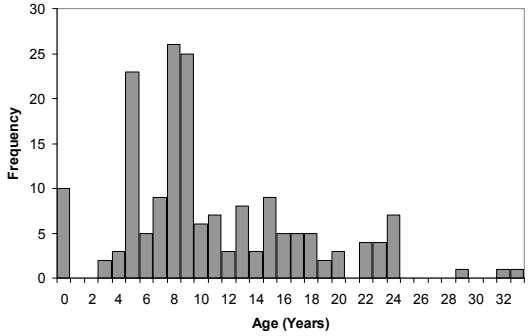

Figure 4: Age Distribution of Sheepshead Collected in 2006

There was no significant evidence of systematic disagreement between ages estimated by Reader 1 and Reader 2 (χ^2 = 30.9, df = 29, P = 0.3725) (Figure 5).

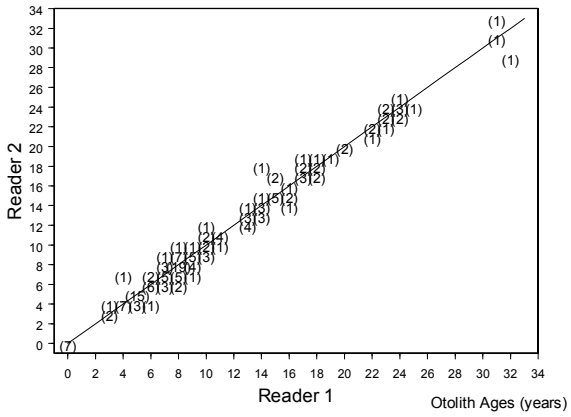

Figure 5. Comparison of age estimates from Reader 1 and Reader 2.

Marginal incremental analysis indicated that annulus formation on the sheepshead otolith occurred once a year between June and July, and was approximately one

month later than annulus formation in sheepshead collected in the South Atlantic and Gulf of Mexico (Figure 6).

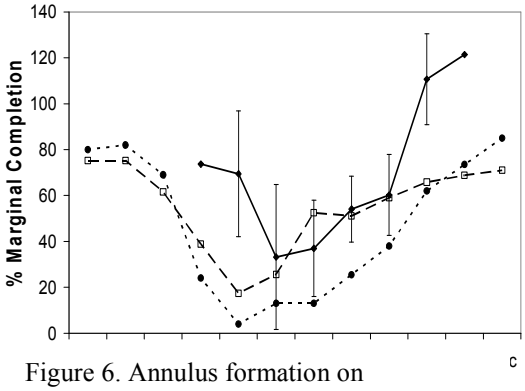

Figure 6. Annulus formation on sheepshead otolith occurred in June and July of 2006 in Chesapeake Bay, Virginia (solid line with solid diamond) whereas it occurred in May in Florida (dotted line with solid circle) and Louisiana (dashed line with open square).

3. Growth

Kimura test indicated that there was no significant difference between sheepshead male and female growth rates (P = 0.4). Therefore, both sexes were pooled to develop a sex-combined von-Bertalanffy growth model. Then, the von-Bertalanffy growth model of sheepshead was compared to the von-Bertalanffy growth models reported in the previous studies of sheepshead in the South Atlantic and Gulf of Mexico. There were differences between the sheepshead growth rate in Chesapeake Bay, Virginia, and those in South Atlantic and Gulf of Mexico. Sheapshead in Chesapeake Bay grew very rapidly before 5 years old but slowed by age 10. Lengths thereafter varied asymptotically about the mean (Figure 7).

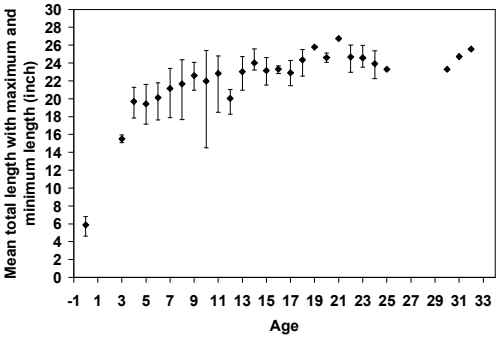

Figure 7. Mean total length, maximum length and minimum length at age for sheepshead collected in Chesapeake Bay from early May to early November of 2006.

The von-Bertalanffy growth models predicted that Chesapeake Bay sheepshead could reach a fork length of 440 mm (about 17 in.) at age 5 whereas sheepshead were smaller than 380 mm (about 14 in.) at the same age in the South Atlantic and Gulf of Mexico (Figure 8).

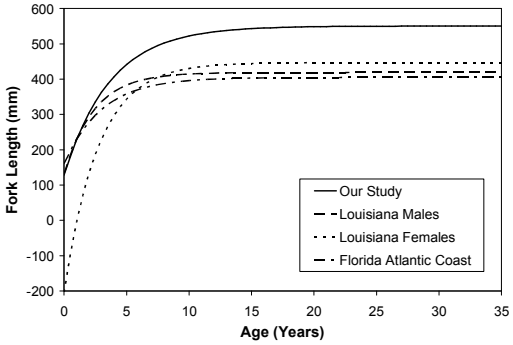

Figure 8. Comparison of von-Bertalanffy growth rates between sheepshead population in Chesapeake Bay, Virginia, and its southern populations.

4. Maturity and spawning season

The macroscopic examination indicated that 204 fish were mature, 60 fish were YOY, and 7 fish were unknown sex among the 271 sheepshead collected in 2006 and 2007. The mature fish ranged in maturity from Stage 1 to Stage 5. Of the mature fish, 9 fish collected in May and June were at Stage 4 (Spawning stage), indicating a local spawning season from May to June in Chesapeake Bay, Virginia.

The YOY fish (Stage 0) were collected from July to November. Figure 9 and Figure 10 illustrates the number of fish (number in each bubble) collected in 2006 and 2007 at different maturity stages in different months.

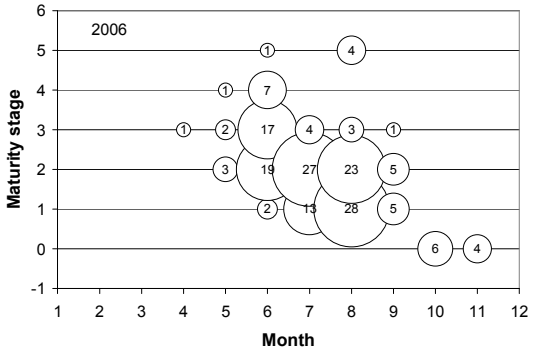

Figure 9. Macroscopic analysis on maturity of sheepshead collected in 2006 by ODU.

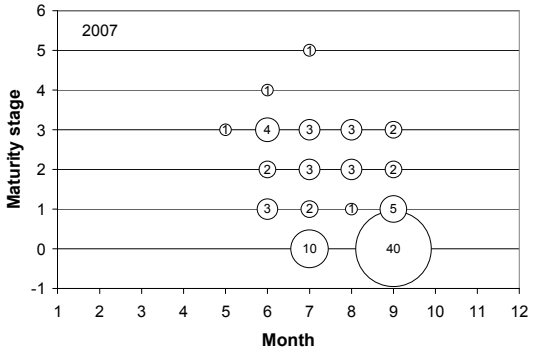

Figure 10. Macroscopic analysis on maturity of sheepshead collected in 2007 by ODU.

We were able to collect 80 ovaries in 2006 and 2007, ranging in fresh weight from a minimum of 0.9 g to a maximum of 367.4 g. Histology slides have been made for 67 ovaries of sheepshead collected in 2006 and analyzed in this study. Preliminary microscopic analysis indicates that sheepshead in Chesapeake Bay were multiple spawners. Individual females were spawning repeatedly during the spawning season, characterized by the presence of oocytes in all stages of development throughout the spawning season of 2006.

DISCUSSION

The length distributions of sheepshead collected in 2006 and 2007 were significantly different. 91% of the fish collected in 2006 were larger than 18 inches in total length and only 6% of fish were YOY. However, 41% of the fish collected in 2007 were larger than 18 in. in total length and 54% of fish were identified as YOY. Such a difference in length distributions was largely due to different sampling scheme between 2006 and 2007. We collected majority of our fish from recreational and commercial fisheries which did not target small sheepshead in general. In 2007, besides continuing to collect fish from recreational and commercial fisheries, we also collected fish from VIMS spotted seatrout trawling which was a very effective at sampling small fish.

Combined with the results from previous studies (Beckman et al. 1991; Dutka-Gianelli and Murie 2001), our study confirmed that the annulus formation on sheepshead otolith occurred once a year by using marginal incremental analysis. Both Beckman et al. (1991) and Dutka-Gianelli and Murie (2001) found that the annulus formation on sheepshead otolith occurred in May in Louisiana and Florida, respectively, whereas our study found that the annulus formation on sheepshead otolith occurred Between June and July of 2006 in Chesapeake Bay, Virginia. This month delay of the annulus formation is most likely due to colder water temperature in early summer in Virginia than in the South Atlantic and Gulf of Mexico.

Several findings from this study indicated that there could be a local population of sheepshead in Chesapeake Bay, Virginia, with its unique vital rates compared to its southern populations in the South Atlantic and Gulf of Mexico. First, the oldest sheepshead in Chesapeake Bay caught so far was 33 years old, much older than those (14 years old) caught in Georgia (Music and Pafford 1984). Second, sheepshead in Chesapeake Bay also grew more quickly with larger body size at age than those populations in Florida (Dutka-Gianelli and Murie 2001) and Louisiana (Beckman et al. 1991). Third, sheepshead spawned Between May and June of 2006 and 2007 in Chesapeake Bay and their YOY were observed between July and November in our samples.

However, this report presents preliminary results mainly from our first year data. We recommend that it should be cautious to draw any ultimate conclusions from this report. We expect to collect more data during the third year to reach our goal of 500 fish. To increase the sample size during our third year, we will contact local anglers' clubs to organize a sheepshead tournament during the sampling season of 2008 and continue to collect sheepshead from the local marinas, commercial fisheries, and the independent sampling. Sufficient sample sizes will allow us to conduct sophisticated statistical analysis and to provide more accurate results on sheepshead population dynamics in Chesapeake Bay.

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